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| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
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| 09/689,930      | 10/13/2000  | Chung-Shi Liu        | TS99-656            | 7448             |

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| EXAMINER |
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SAGAR, KRIPA

| ART UNIT | PAPER NUMBER |
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1756

DATE MAILED: 02/14/2002

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Please find below and/or attached an Office communication concerning this application or proceeding.

## Office Action Summary

Application No.

09/689,930

Applicant(s)

LIU ET AL.

Examiner

Kripa Sagar

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

### Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

### Status

- 1) ☒ Responsive to communication(s) filed on \_\_\_\_\_.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

### Disposition of Claims

- 4) ☒ Claim(s) 1-30 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-30 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

### Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on \_\_\_\_\_ is: a) ☐ approved b) ☐ disapproved by the Examiner.  
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

### Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).  
a) ☐ All b) ☐ Some \* c) ☐ None of:  
1. ☐ Certified copies of the priority documents have been received.  
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.  
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).  
\* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).  
a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

### Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892) 4) ☐ Interview Summary (PTO-413) Paper No(s). \_\_\_\_\_
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948) 5) ☐ Notice of Informal Patent Application (PTO-152)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 2. 6) ☐ Other:

## DETAILED ACTION

### ***Claim Rejections - 35 USC § 112***

1. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

2. Claims 1-30 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claims 1, 11 and 17 recite the limitation "said composite layers of dielectric insulation and ..." (e.g. claim 1, line 8) and "said composite layers of dielectric;" (e.g. claim 1, line 7). The claims refer to "composite layers of insulation comprising...." (e.g. claim 1, line 2) but have no reference to composite layers of dielectric or dielectric insulation. There is insufficient antecedent basis for these limitations in the claims.

Claims 3, 13 and 23 recite the limitation on the thickness of the dielectric material layer (e.g. Claim-3, l-4) as 4000-1200Angstroms. This limitation is unclear.

The claims recite the limitation "selected from the group consisting of  $\text{SiOF}_x$ ,  $\text{SiOC}_x$ ,  $\text{SiOH}_x$ ". This group should be properly defined as "consisting of  $\text{SiOF}_x$ ,  $\text{SiOC}_x$  and  $\text{SiOH}_x$ ". The compositions of the dielectric materials are not defined – the values of the subscripts 'x' are not specified and make the claims vague and indefinite.

Claims 4, 14 and 24 recite the limitation "selected from a group consisting of silicon nitride,  $\text{Si}_x\text{N}_y$ ,..." (e.g. claim 4, line 3) The group "silicon nitride" is not defined and renders the claims vague and indefinite. The composition  $\text{Si}_x\text{N}_y$  is not defined since the values of subscripts are not defined rendering the claims vague.

Claim 4 further recites, "without said etch stop layers". Claim 1 refers to one etch stop layer intermediate to the two insulation layers. There is no reference to etch stop "layers" in claim 1. There is insufficient antecedent basis for this limitation in the claims. Claims 6, 16, 26, recite the limitations "positive type photoresist" in line 2. The use of the word "type" renders the claims vague and indefinite.

These claims also recite the limitation "photoresist selected from the group consisting of I-line positive resists.." in line 2. The elements of the group of I-line positive resists are not defined and render the claims vague and indefinite.

Claims 7, 17, 27 recite the limitations "positive type photoresist" in line 2. The use of the word "type" renders the claims vague and indefinite.

These claims also recite the limitation "photoresist selected from the group consisting of positive DUV, 248nm photoresist.." in line 2. The elements of the group of DUV positive resists are not defined and renders the claims vague and indefinite.

Claims 9, 19, and 29 recite the limitation "trench / via" in line 2. This is interpreted as "trench or via"; whereas the specification teaches the filling of trench and via with metal.

The limitations are unclear, vague and indefinite.

It is recommended that the diverse dielectric, insulation, etch stop and photoresist layers be named or enumerated and consistently recited in the claims.

### ***Claim Rejections - 35 USC § 103***

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the

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invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

4. Claims 1-7,9-17,19-27,29,30 are rejected under 35 U.S.C. 103(a) as being unpatentable over US Pat. 6110648 to Jang in view of US Pat. 6103456 to Tobben et al. and further in view of US Pat. 4770739 to Orvek et al. The listed claims recite the dual damascene process using two photoresists with different spectral responses to form a trench and an aligned via in a multilayered substrate.

Jang teaches the dual damascene method for enclosing a copper conductor in a multilayered substrate. The three-layered stack consists of (a) lower dielectric layer (LLD) (b) an intermediate etch stop layer and (c) an upper dielectric layer (ULD) over other layers on a substrate (col.5, l.27-29). Low permittivity dielectrics are formed of silicon oxide materials known in the art (col.5, l. 40-47). The etch stop layers consist of silicon-nitrides and -oxynitrides (col.5, l.53-57).

The processing steps include: forming a first photoresist layer and patterning it for a via (col.5, l.64-65); forming a second photoresist layer and patterning it for a conductive line (col.6, l.12-14); etching the diverse layers to form a via and a trench (col5, l.64—col.6, l.26), removing the resist layers and forming a barrier layer (col.6, l.26-42); filling the trench and via, with metal; and planarizing with a chemical mechanical polish (CMP) (col.6, l. 43-47).

Jang's invention is related to the manufacture IC chips and to forming interconnects between layers on semiconductor substrates (col.1, l. 7-12). Multilevel structures can be formed by repeating the process (col.2, l.3-6).

Jang does not teach the use of a top insulating dielectric layer over the three-layer stack recited in claims 1,5,11,15,21,25. It does not teach the use of a near-UV (365nm) and a deep-UV (268nm) photoresist recited in claims 1,6,7, 11,16,17,21,26,27.

Tobben teaches the prior-art of dual damascene process with the use of a silicon oxynitride (SiON) layer as an antireflective coating (ARC) (col.5, l.13-25). It teaches the benefits of using SiON (col.4, l.19-28). These include the anti-reflection function under the photoresist, controlled deposition as well as suitability for hard masks. It would have been obvious to one of ordinary skill in the art at the time the invention was made to use SiON as a top dielectric layer over Jang's stack because Tobben teaches that it functions as an ARC as well as a hard mask for etching leading to improved feature definition in the resist and etching of holes in the dielectrics (col.6, l.1-10).

Orvek teaches the use of two resists with different spectral sensitivities. It teaches a bilayer method where the lower layer (planarization layer) is a near-UV resist while the upper layer (resolution layer) is a deep UV resist (col.4, l. 10-13). The near-UV resist is sensitive to radiation in the 310-395nm range, while the deep-UV resist is sensitive in the 185-310nm range (col.5, l.17-19, 22-24). In one embodiment the upper layer is imaged with a 248nm radiation (col.8, example I) and developed. The lower layer is blanket exposed to transfer the image in the areas of the developed upper layer and developed. Orvek teaches that this scheme increases the resolution of images in the deep-UV resist, because the lower layer absorbs deep-UV radiation and minimizes aberrations from reflections (col.6, l.25-38). Additionally the lower layer performs as a superior dry etch mask compared with deep-UV resists (col.9, l.33-37). Orvek teaches

its application in metallization process (col.9, l. 66-67). It would have been obvious to one of ordinary skill in the art at the time the invention was made to use a deep UV resist over a near-UV resist in Jang and Tobben's damascene process, because Orvek teaches that it increases image resolution in the resist (col.5, l.61-65) and feature resolution during dry etching of stepped features (col.6, l.39-48).

5. Claims 8,18,28 are rejected under 35 U.S.C. 103(a) as being unpatentable over Jang in view of Tobben and further in view of Orvek as applied to claims 1- 7,9-17,19-27,29,30 above, and further in view of US Pat to 5843847 to Pu et al. The current claims relate to etchant chemistries and process parameters for reactive ion etching of the dielectric layers in a dual damascene process. The teachings of Jang have been discussed above. Jang teaches the two-step etching of dielectric layers using fluorocarbons and Ar, ashing of resist (col.6, l.3-11, 20-24). Jang's chemistries do not include oxygen-bearing gases.

Pu teaches the etching of dielectric layers and resists (col.2, l.35-38). The components of the process gas comprise a fluorocarbon, carbon-oxygen and nitrogen bearing gases (col.2, l.40-46). In a preferred embodiment the listed components include  $\text{CHF}_3$ ,  $\text{CH}_3\text{F}$ ,  $\text{C}_2\text{F}_6$ ,  $\text{C}_4\text{F}_8$ ,  $\text{CF}_4$ ,  $\text{N}_2\text{O}$ ,  $\text{N}_2$  and Ar. It teaches prior-art compositions that include CO (col.1, l.65). The compositions and parameters are adjustable to the materials being etched (col.7, l.42-48). It would have been obvious to one of ordinary skill in the art at the time the invention was made to use Pu's process to etch the layers on Jang and Tobben's stack with Orvek's resists, because Pu teaches that this leads to better etch

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selectivity, high etch rates and low organic contamination (col.8, I.34-38) while providing vertical wall profiles (Tables I, III).

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Kripa Sagar whose telephone number is 703-605-4427. The examiner can normally be reached on 8:00AM--5:00PM (M-F).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Mark F Huff can be reached on 703-308-2464. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9310 for regular communications and 703-872-9311 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0661.

  
KATHLEEN DUDA  
PRIMARY EXAMINER  
GROUP 1400

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February 11, 2002